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Innovation and Finance: A Firm Level Analysis on Emerging Markets

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INNOVATION AND FINANCE:
A FIRM LEVEL ANALYSIS ON EMERGING MARKETS

by

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ABSTRACT

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Economic theory suggests that the more financially constrained a firm, the lower its ability to allocate resources for innovation. I test this theory using firm-level survey data that covers 29 Eastern European and Central Asian countries. The survey is conducted in 2002, 2005, and 2009, and covers nearly 12,000 enterprises. I construct two baseline probit models to test the impact of financial constraints on firms' ability to innovate a new product or upgrade an existing product. Existing literature suggests that the more financially constrained a firm, the less likely they are to innovate. Previous studies have also noted the reverse causality that may exist between these two indicators. To account for this potential endogeneity problem, I run probit regressions using instrumental variable techniques. My empirical findings suggest that the greater the difficulty of access to finance, the less likely a firm is to innovate. Conversely, I find that the following measurements positively influence a firm's innovational activity: whether or not the firm has is internationally recognized; the percent of employees with a university degree; the number of full time employees; percent of skilled workers; and, whether or not the firm's supplies were imported directly.

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1. INTRODUCTION

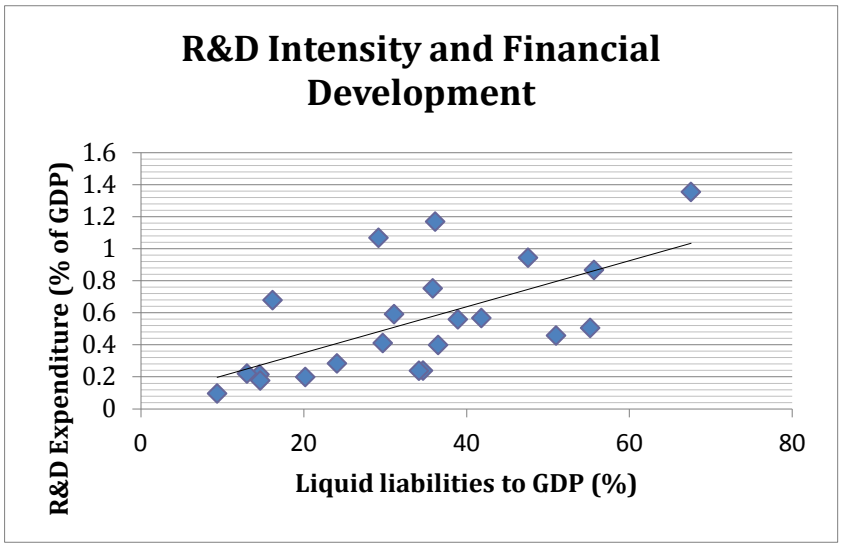
1.1. Motivation of Paper

A Schumpeterian view on growth suggests a positive relationship between economic growth and financial development. Joseph Schumpeter (1912) explained "well-functioning banks spur technological innovation by identifying and funding those entrepreneurs with the best chances of successfully implementing innovative products and production processes"[1]. Empirical studies show, however, that financial frictions may act as an obstacle for both the R&D and investment opportunities for firms. Macroeconomic studies emphasize this as well, suggesting that the overall development of a country is correlated with the development of its financial markets. Data also suggests a positive correlation between R&D intensity and financial development among emerging market firms[2]. **Figure 1** displays this relationship for the 29 countries analyzed in this paper. This relationship proposes that firms must manage their financial situations well to obtain any innovational success. These stylized facts motivate my microeconomic analysis of the impact various financial development indicators have on innovational activity.

[1] Levine, Ross. "Financial Development and Economic Growth: Views and Agenda". *Journal of Economic Literature, Vol. XXXV (June 1997).* pp 688.

[2] *Note:* Financial development is generalized as liquid liabilities as a percentage of GDP—or M3. Liquid liabilities are defined by the World Bank Group as the sum of currency and deposits in the central bank (M0), plus transferable deposits and electronic currency (M1), plus time and savings deposits, foreign currency transferable deposits, certificates of deposit, and securities repurchase agreements (M2), plus travelers checks, foreign currency time deposits, commercial paper, and shares of mutual funds or market funds held by residents.
Note: R&D intensity is generalized as R&D expenditure as a percentage of GDP, which can be defined as current and capital expenditures—both public and private—on creative work to increase knowledge. Such knowledge is inclusive of humanity, culture, and society, as well as the use of knowledge for new applications. The R&D component covers basic research, applied research, and experimental development undertaken by enterprises within the observed economies.

Figure 1:



Source: WorldBank.org

1.2. Purpose of Paper

The purpose of this paper is to analyze, at the firm level, the extent to which financial indicators—such as financial stability and credit constraints—affect innovation. The scope of this data is limited to 29 emerging market economies as specified by the EBRD and World Bank. I use panel data from the 2002, 2005, and 2009 Business Environment and Enterprise Performance Surveys (BEEPS) to address this question. I consider two dependent variables as indicators of innovation at the firm level. The first captures whether or not the firm has introduced new products or services in the last three years, denoted ***(Innov)***. The second captures whether or not the firm has upgraded an existing product or service in the past three years, denoted ***(Upgrades)***. I have constructed both of these dependent variables as dummy variables measured by a response of either yes, no, or don't know[3]. **Figures 2** and **3**[4] exhibits the dependent variables from the

[3] *Note:* Since less than 1 percent of the firms answered 'don't know', these observations will be dropped when running regressions.

BEEPS data, which displays the distribution of firms' responses. Of the enterprises studied, 56 percent answered yes to the introduction of new products or services while 44 percent answered no. Similarly, 60 percent of the firms answered yes to upgrading an existing *In the last three years, has this establishment introduced new products or services?* product while 40 *In the last three years, has this establishment upgraded an existing line/service?* percent answered no. This distribution suggests that some indicator or collection of indicators is allowing for variety among firms' innovational activity.

Figure 2:

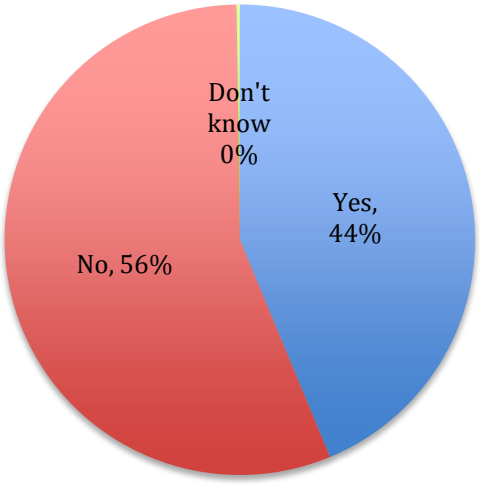
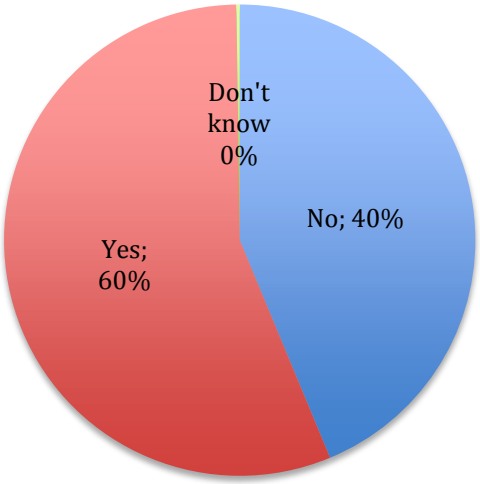


Figure 3:



[4] *Source:* BEEPS raw data

To estimate the determinants of this distribution, I examine a series of independent variables capturing various measures of financial stability and credit constraint related indicators[5]. I expect to find that financial instability and credit constraints negatively impact emerging market firms' ability to innovate[6].

The data also demonstrates the distribution of innovational activity, upgrades, and difficulty of access to finance across each of the 29 countries[7]. **Table 1**, **Table 2,** and **Table 3** display these relationships. Lithuania demonstrated the greatest innovational activity, with roughly 56 percent of its firms answering yes to innovating within the past 3 years. Also, nearly 52 percent of its firms responded that accessing finance was no obstacle, and 19 percent reported it as a moderate obstacle. Conversely, Uzbekistan exhibited the lowest level of innovational activity with only 22 percent of its firms introducing new innovations. Concerning its difficulty of access to finance, 35 percent reported no obstacle, 21 percent minor obstacle, 23 percent moderate obstacle, and 18 percent reported it to be a major obstacle. This distribution across countries suggests that firms who experience greater difficulties in accessing finance have a harder time innovating new products. Similar relationships exist when evaluating whether or not a firm has upgraded an existing product or service. Nearly 78 percent of Croatia's firms upgraded their main product over the three examined periods, whereas only 33 percent of

[5] *Note:* These variables are as follows: financial constraints faced by the firm; the number of full-time employees; the percent of employees with a university degree; the percent of skilled employees; the age of the firm (relative to 2014); whether or not the firm has an internationally recognized quality certificate; whether or not the price of the main product has increased, decreased, or remained the same; the percent of sales that were sold nationally; whether or not any material inputs or supplies were directly imported; the population size where the firm is located; whether or not service payments are overdue; the percent of fixed assets funded by internal funds; and, the number of years of experience held by the top manager.

[6] To correct for the endogeneity of financial constraints, lagged values could be used to observe how constraints in an earlier year affect innovation in a latter. However, since the dependent variables are lagged (measuring activity within the past 3 years), real measures of the independent variables will be used.

[7] See **Table 1, Table 2,** and **Table 3** in *Appendix*

Uzbekistan's firms made upgrades. Also, 44 percent of the firms in Croatia reported accessing finance to be no obstacle while 20 percent viewed it as a minor obstacle. Thus, the data suggests that the difficulty a firm has accessing finance also has an effect on the upgrades made.

Though both measures of innovation vary with respect to a firm's financial situation, the complexity associated with each variable presents a clear distinction between the two. Theoretically, firms will find it more difficult to innovate a new product than to upgrade something previously created. This difference is slightly reflected in the average number of firms that have innovated in each country versus the average number of firms that have upgraded: 56 percent versus 60 percent. The upper and lower bounds of these measures, however, show the greatest difference between both variables, ranging from 22 percent to 56 percent for innovation and 33 percent to 78 percent for upgrades over the past three years; marginally, firms are more likely to upgrade an existing product then they are to innovate. Therefore, it follows that the difficulty a firm faces accessing finance has a negative impact on the R&D intensity of a firm.

Table 1: Country specific ratios of innovational activity

Country	Innov 0	1	Total
Albania	250	166	416
Armenia	456	398	854
Azerbaijan	435	345	780
Belarus	391	391	782
Bosnia	328	308	636
Bulgaria	415	337	752
Croatia	257	246	503
Czech Republic	525	250	775
Estonia	348	248	596
FYROM	342	293	635
Georgia	421	205	626
Hungary	778	338	1,116
Kazakhstan	809	452	1,261
Kyrgyz	350	243	593
Latvia	320	258	578
Lithuania	278	349	627
Moldova	409	412	821
Montenegro	51	61	112
Poland	1,060	757	1,817
Romania	714	462	1,176
Russia	1,024	1,039	2,063
Serbia	444	378	822
Slovakia	345	243	588
Slovenia	373	264	637
Tajikistan	381	288	669
Ukraine	824	859	1,683
Uzbekistan	705	202	907
Total	13,033	9,792	22,825

Table 2: Country specific ratios of upgrades to existing products

Country	Upgrades 0	1	Total
Albania	222	194	416
Armenia	334	520	854
Azerbaijan	394	386	780
Belarus	208	574	782
Bosnia	194	442	636
Bulgaria	381	371	752
Croatia	111	392	503
Czech Republic	414	361	775
Estonia	212	384	596
FYROM	272	363	635
Georgia	276	350	626
Hungary	581	535	1,116
Kazakhstan	580	681	1,261
Kyrgyz	228	365	593
Latvia	189	389	578
Lithuania	250	377	627
Moldova	314	507	821
Montenegro	45	67	112
Poland	849	968	1,817
Romania	479	697	1,176
Russia	678	1,385	2,063
Serbia	265	557	822
Slovakia	161	427	588
Slovenia	281	356	637
Tajikistan	243	426	669
Ukraine	536	1,147	1,683
Uzbekistan	610	297	907
Total	9,307	13,518	22,825

Table 3: Country specific ratios of difficulty of access to finance

	how much of an obstacle is: access to finance					
Country	No Obstac	Minor Obs	Moderate	Major obs	Very Seve	Total
Albania	147	90	89	55	3	384
Armenia	222	164	246	170	38	840
Azerbaijan	211	223	193	120	23	770
Belarus	210	145	185	194	24	758
Bosnia	168	117	181	116	26	608
Bulgaria	265	120	178	167	11	741
Croatia	206	95	75	83	11	470
Czech Republic	193	167	229	150	14	753
Estonia	345	92	90	41	4	572
FYROM	190	111	163	108	29	601
Georgia	226	91	135	128	29	609
Hungary	474	154	233	214	7	1,082
Kazakhstan	471	264	257	149	78	1,219
Kyrgyz	206	106	161	100	13	586
Latvia	288	68	133	50	16	555
Lithuania	291	81	104	68	18	562
Moldova	219	159	179	171	59	787
Montenegro	51	20	26	9	3	109
Poland	406	347	452	543	23	1,771
Romania	346	191	316	258	42	1,153
Russia	632	324	447	379	202	1,984
Serbia	194	143	211	224	30	802
Slovakia	219	131	112	86	9	557
Slovenia	270	161	118	67	12	628
Tajikistan	219	150	163	85	40	657
Ukraine	494	272	389	368	104	1,627
Uzbekistan	301	180	200	160	24	865
Total	7,464	4,166	5,265	4,263	892	22,050

1.3. *Contributions of Paper*

Gorodnichenko and Schnitzer (2011) is the closest work to this thesis. Similar to my hypothesis, Gorodnichenko and Schnitzer (2011) test how a firm's difficulty of access to external finance, the cost of external finance, and other financial indicators affect innovation. My thesis provides a unique contribution to such literature. First I use the approximate collateral needed as a percent of the loan value or the value of the line of credit as a direct measure of financial constraints, which was not considered in Gorodnichenko and Schnitzer's (2011) analysis. Second, the number and distribution of firms used in Demirguc-Kunt and Maksimovic's (1998) study is close to that of those used in this thesis—26 versus 29 with cross-country analysis—however the composition of the firms is different. My analysis places focus on commercial, service, or industrial business establishments, whereas DM (1998) uses large, publically traded manufacturing firms. My empirical findings suggest that a firm's difficulty of access to finance has a negative impact on both its innovational activity, as well as its decision to upgrade an existing product or service. Conversely, I find that the approximate amount of collateral needed, as a percent of the loan value or the value of the line of credit, does not have a statistically significant impact on a firm's innovation activity, nor its decision to upgrade. I also find that whether or not a firm has utility payments overdue by more than 90 days is a good instrument to study the casual effects financial constraints have on firms' decision to innovate and upgrade.

1.4. *Organization of Paper*

The next section **(2)** will review the existing literature related to my analysis of financial stability, credit constraints, and innovational activity. Such literature excludes

industry-level analyses, and is thus limited to firm-level studies. Section **(3)** will present a description of the BEEPS panel dataset used. Section **(4)** describes the econometric specification of my thesis, which provides the two baseline equations tested, a detailed description of the independent and dependent variables estimated, and the summary statistics of these variables. This section will conclude by addressing the instrumentation strategy used. Section **(5)** presents an analysis of the empirical results for each stage of analysis, and Section **(6)** concludes the findings of this thesis. The subsequent sections provide a list of references, as well as the Appendix of Tables.

2. LITERATURE REVIEW

2.1. *Financial Development and Economic Growth*

From a macroeconomic standpoint, abundant evidence suggests that the development of a country is strongly correlated with the development of its financial markets. Levine (2005) presents both theory and evidence outlining how countries with stronger economies, or OECD countries, have the ability to lessen any financial constraints faced by a firm. In the context of emerging markets, Levine (2005) notes that the financial arrangements of these countries have the ability to change not only the constraints on a firm, but any incentives as well. Levine (2005) discusses what he finds to be the primary function of financial systems: to facilitate the allocation of resources in an uncertain environment over time and varying locations. In his earlier literature, Levine (1997) presents this function as 'A Theoretical Approach to Finance and Growth' with

Figure 4

. A Theoretical Approach to Finance and Growth

Source: Levine (2005)

market frictions as the driving force of growth[8]. This progression can be seen in **Figure 4,** where Levine argues that capital accumulation and technological innovation are two channels through which economic growth can be affected. This flow demonstrates the following: if a firm is experiencing financial constraints, having adequate access to finance through financial markets and functions is essential for their ability to innovate, accumulate capital, and ultimately grow. Levine references various econometric models found in existing literature that support this finding as well.

One of these models referenced comes from Demirguc-Kunt and Maksimovic's (1998) examination of how firms' constraints from investing in profitable growth opportunities are influenced by their financial development. For each firm included in their sample, DM estimates firms' external financing needs by calculating the rate of growth of two determinants: internal funds, and internal funds *and* short-term borrowing. Three assumptions were made when relating a firm's growth rate of sales to its need for investment funds. The first is that the ratio of assets used in production to sales is constant. The second is that the profit per unit of sales is constant. The final assumption is that the economic depreciation rate is equal to the accounting depreciation rate. After running a financial planning model, DM (1998) found that the excess growth of firms is *positively associated* with banking size and stock market liquidity. Excess growth captures when the rate of growth of the firm is larger than its rate of growth with just retained earnings and short-term borrowing. Thus, DM (1998) shows how firms' financial development may constrain investment opportunities. Profitable investment opportunities allow for the enhancement of a firm's financial stability, and thus allows for

[8] *Note:* Levine's market frictions are comparable to the definition of financial constraints in this thesis.

the accumulation of capital. Such capital can then be put towards either innovational activities or the reduction of credit-based obligations. In the context of my analysis, this finding emphasizes to the importance of studying emerging markets at the firm level; where there is increased financial activity, there is more innovational opportunity.

Gordonichenko, Svenjnar, and Terrell (2009) combine Levine (2005) and DM's (1998) notion of financial development, financial markets, and investment opportunities by exploring globalization, testing to see how it effects innovation in emerging markets. They do so by analyzing how foreign firms impact the innovation of domestic firms within emerging market economies, which is measured by the competition from—and linkages with—differing firms. As defined by Gordonichenko, Syvenjnar, and Terrell (2009), globalization allows for opportunities and pressures to arise among emerging market firms, which encourage firms to innovate in order to improve their competitive position. Globalization also encourages trade and foreign direct investment (FDI) from companies, entities, and financial institutions, thus contributing to a firm's financial development and ability to grow. Two mechanisms are assumed in this study, which are important determinants of a firm's innovation: knowledge transfers and competition, both of which may be brought about through various channels like FDI and international trade. The foundation for Gordonichenko, Syvenjnar, and Terrell's (2009) observations are associated with the Schumpeterian Growth Model. Firstly, they recognize that large firms operating in concentrated markets are the most powerful engines of process. This power is reflective of these firms' ability to appropriate the returns from inventive activity, and consequentially innovate with more ease then other smaller, more financially constrained firms. In using the 2002 – 2005 BEEPS data set, Gordonichenko, Syvenjnar, and Terrell

(2009) find that greater pressure from foreign competition stimulates innovation. They also find that vertical relationships induce innovation by domestic firms, where vertical refers to the transfer of capabilities among firms within emerging market economies.

2.2. Financing of R&D

Another relevant set of literature reviewed to develop a basis for my thesis concerns the financing of firms' R&D expenditures. Using Levine (2005) as the foundation for establishing a connection between financial development and economic growth, Brown, Fazzari, and Petersen (2007) address the question of whether or not financial effects are great enough to influence aggregate R&D. However, no real evidence exists concerning which financial channels are worth analyzing. Brown, Fazzari, and Petersen (2007) thus choose to consider the financing of R&D as a potential channel for three main reasons. Firstly, the way in which firms finance their R&D expenditures is a critical determinant of growth. Secondly, R&D creates knowledge spillovers, a known component of endogenous growth models. Lastly, Brown, Fazzari, and Petersen (2007) recognize that R&D may be difficult to finance with external sources, which suggests that a firm's ability to rely internal versus external finance for R&D expenditures may be crucial for innovational activity. Through the analysis of young, high-tech companies in the U.S. during the mid and late 1990s, their empirical findings propose that a shift in the availability of internal and external equity finance allows for the relaxation of financing constraints among firms. This reduction of credit constraints, they argue, is what allowed for the significant boom in R&D in the 1990s, just as the tightening of constraints between 2001 and 2004 slowed growth. Thus, these findings would suggest that for firms within emerging market economies, similar

implications could be utilized when considering how financial and credit constraints affect the ability to innovate.

2.3. Credit / Internal Finance Constraints and R&D

How a firm chooses to finance its R&D expenditures is directly linked to the credit and internal financial constraints realized by the firm. Gorodnichenko and Schnitzer (2011) demonstrate this relationship through a description of a firm's business cycle within an emerging market, which is broken down into stages[9]. In stage one, the firm is able to rely on internal funds from any positive cash flows to finance their R&D expenditures. Since the beginning stages of any innovational activity are subject to asymmetric information, the utilization of external finance is generally not an option. In stage two, the firm must finance the production of their new innovation. Preferably, the firm will continue to use whatever internal finance it maintains. Many times, however, the firm exhausts its internal funds in the first stage of the business cycle. This forces the firm to rely on external sources to help finance their innovation, leaving them to be subject to financial constraints.

Gorodnichenko and Schnitzer (2011) capture such constraints through the likelihood with which firms need to rely on external financing, which may be broken down into two differing measures. The first measure is an instance where the firm has spent a significant amount of its internal funds in stage one, thus lowering its likelihood of having sufficient funds of its own come stage two. The second measure describes an instance where the investor experiences a shock to liquidity. This shock could be the product of many factors, such as late payments made by their customers. Though the

[9] *Note:* These stages are a series of assumptions made by GS (2011).

investor has no influence over this type of event, it would still lower the likelihood of the firm having sufficient internal funds. Two implications can be derived from these measures. The first is that firm innovation is positively correlated with financial constraints; innovation reduces internal funds and thus increases the probability of financial constraints. The second demonstrates how endogenous shocks are unaffected by a firm's innovational activity, though the reverse holds true: shocks such as liquidity may hinder innovational activities by restricting available finances. Therefore, they hypothesize that the more a firm relies on external finance, the greater the negative impact of financial constrains on the firm's innovational activities.

There are a series of findings from Gorodnichenko and Schnitzer's (2011) study, which collectively support their hypothesis that financial constraints obstruct firms' ability to successfully innovate. Most importantly, they find unambiguous evidence that financial constraints negatively impact firms' ability to innovate. My analysis stands as an extension of this study, using updated panel data from BEEPS and incorporating a new component to the financial constraint variable: collateral needed by the firm. Thus, I expect to find my results will mirror that of Gorodnichenko and Schnitzer's (2011) study, with the replacement of cost of external finance for collateral providing new insight into firms' ability to innovate.

Guariglia, Liu, and Song (2008) explore a similar hypothesis, evaluating whether or not the availability of finance places constraints on individual firm growth. Using Chinese firms as their basis, they hypothesize that financially constrained firms will

exhibit a one-to-one relationship between internal finance and growth[10]. Their results support this hypothesis, showing that private firms are financially constrained by the availability of their internal funds. The reasoning attributed to this finding is based on discriminations from the banking sector; banks consider private enterprises to be riskier than public. This inequity stems from not only an increase in competition by private firms on public enterprises, but from the change in the banking reforms as well[11]. As Guariglia, Liu, and Song (2008) explain, once approved a firm will borrow from a bank up to a certain threshold. Past that point, the firm will begin looking to alternative sources of finance, which are assumed to be more expensive than bank loans. This assumption further supports the notion that relying on external finance is not only expensive, but may hinder growth. Thus, an increase in credit constraints and a decline in growth both have the potential to affect a firm's financial stability and, consequentially, its ability to innovate.

The theory of the growth in small firms, as well as whether or not these firms are constrained by internal finance, is further analyzed in the paper by Carpenter and Petersen (2002). Their hypothesis consists of three quantitative assumptions. The first claims that with binding financial constraints, a small firm will exhibit around a dollar-to-dollar relationship between growth in assets and internal finance, as was seen in Guariglia, Liu, and Song's (2008) analysis. The second assumes that firms will exhibit a leverage effect when their access to debt is dependent upon collateral. Leverage effects capture instances where internal finance generates more than a dollar-to-dollar ratio with

[10] *Note:* a one-to-one relationship is defined as an equally proportional relationship between the two measurements: internal finance and growth

[11] *Note:* In the 1990s, banks began scrutinizing loan applications more carefully, causing non state-owned-enterprises to experience a decline in profitability and a slowdown in growth.

growth. The final assumption is that since firms can obtain external equity finance, and thus are able to relax their internal financial constraints, there will be a weaker relationship between internal finance and growth. Carpenter and Petersen (2002) find that their hypotheses can be supported: the growth of most firms is constrained by internal finance. This finding mirrors that of previous literature, suggesting that financial constraints affect a firm's ability to expand, and thus decreases their capability of innovating new products.

As noted, potential policy implications that could correct for credit and financial restraints could be to both reduce the cost of and enhance the access to external finance. Love (2003) investigates this by analyzing whether or not financial developments have the ability to ease any financial constraints faced by a firm. The findings suggest that firms with financial constraints tend to postpone any investments until the next period, because they behave as though they have low discount factors[12]. On a macro scale, Love (2003) finds that the magnitude of the cost of capital for financially constrained firms in countries with low financial development—such as emerging markets—is twice as large as those firms in countries with greater development. Findings also suggest that at the firm level, financial development removes any expansionary obstacles, as well as allows for beneficial impacts on small firms. This implies that studying whether or not financial stability and credit constraints affect innovation is a question worth examining; the more stable and developed a firm, the less intensive their financial constraints. The less constrained a firm is financially, the more internal funds they will have to put towards financing any innovations or improvements upon existing products. Aghion, Berman and

[12] *Note:* Discount factors refer to a high cost of capital.

Eymard (2012) study a similar hypothesis, testing the relationship between a firm's R&D behaviors and its credit constraints. Their findings suggest that in times of economic turmoil, firms with greater credit constraints experience a drop in R&D investments. However, when the economy turns around, these investments do not proportionally increase. Thus Aghion, Berman and Eymard's (2012) study proposes that the more financially stable an economy and its firms, the more likely the success of any R&D investments.

Collectively, a review of previous literature suggests that financial stability, as well as credit constraints, have an effect on firms' innovational activity. Such literature also explains how factors like growth, investment opportunity, and access to both internal and external finance affect the performance of a firm's R&D expenditures. In each of these instances, greater constraint of a firm's financials negatively impacts any advancement in growth, investment, credibility, and innovation. Using panel data from the Business Environment and Enterprise Performance Surveys between 2002 and 2009, this paper will analyze whether or not—at the firm level—financial stability and credit constraints impact innovation. Touching upon the previous literature, I estimate the effect of various channels of financial stability and credit constraints on a firm's innovational activity.

3. DATA AND METHODOLOGY

3.1. Description of Data

The survey data used in this paper is The Business Environment and Enterprise Performance Survey (BEEPS), a product of the European Bank for Reconstruction and Development (EBRD) and the World Bank Group. This survey assesses the environment

for private enterprise and business development across various Eastern European and Central Asian countries. The newest survey data taken is from 2008 – 2009 where 29 countries and nearly 12,000 enterprises are evaluated. This paper utilizes panel data in the years 2002, 2005, and 2009 to test whether or not the financial stability and credit constraints of a firm has an effect on their innovational activity. The data collected highlights feedback from these firms in developing countries (EBRD countries) concerning the state of its private sector in each of the following fields: general information about the establishment of the firm, infrastructure and services, sales and supplies, degree of competition, innovation, inspections, certificates, land and permits, crime, finance, business-government relations, labor, business environment, and performance.

The survey universe of this data is limited to commercial, service or industrial business establishments with at least five full time employees. Any entities considered a primary industry (i.e. agriculture) or within a government department (i.e. education) are outside the parameters of this survey. Enterprises within this universe were subject to a series of requirements, which have been ranked from greatest to smallest priority as: coverage, up to dateness, availability of detailed stratification variables, location identifiers (address, phone number, and email), electronic format availability, and contact names(s). For BEEPS IV, the frames were broken into two distinct classifications: an official frame of establishments supplied by the national statistical office of the country; and a collection of those surveyed in BEEPS III[13].

[13] *Note:* Albania 2007 – 2008 did not have a suitable frame so a blocks enumeration methodology was used.

In BEEPS IV, the same 28 countries from BEEPS III were used *as well as* Mongolia[14]. Stratified random sampling was used to select the firms in each country. This methodology divides a population into subpopulations called strata, each that differ significantly yet are internally homogeneous. Using stratified random sampling instead simple random sampling allows for a gain in precision, flexibility in the choice of the sample design for different strata, and the ability to obtain both population and stratum estimates. Three various levels of stratification were used in each of the countries chosen: industry, establishment size, and region. Diverse combinations of these variables generate the strata cells for each industry, region, and size combination. Size is defined as small (5 to 19 employees), medium (20 to 99 employees) or large (99 or more employees)[15]. Each sample within these countries was stratified along Manufacturing, Retail Trade, and Other Services. Three varying questionnaires were then conducted, the first and fundamental of these three being the Core Module, which includes common questions asked to each firm regardless of its stratification. The second and third are variations of this basic version, yet are tailored towards particular entities. They are denoted as the Manufacturing Questionnaire and the Services Module.

This method of random sampling ensures that each individual observation is properly weighted when making inferences about the population. Since sample sizes are not proportional to the size of each stratum, unweighted observations would allow for biased estimates. Thus the survey data observations are weighted by the inverse of their probability of selection. To adjust for instances where samples were not successfully

[15] This employee count is based on the number of fulltime workers *only*. Part-time employees were not included in this count.

completed, there are three different assumptions used in evaluating eligibility. Each of these assumptions dictates how each weight should be treated: strict, median, or weak assumptions[16]. To correct for subjections to large sampling variations, multiples of the relative eligibility rates for each industry, size, and region are taken from samples larger than the individual cells. These robust weights allow for smaller sampling variations among the values produced, which enhance the validity of the survey data. They take into account the fact that any estimate or indicator describing some feature comes from an individual observation, and thus may not represent equal shares of the population.

The 29 emerging market economies examined in this study are as follows: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Former Yugoslav Republic of Macedonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Mongolia, Montenegro, Poland, Romania, Russia, Serbia (including Kosovo under UNSCR 1244), Slovak Republic, Slovenia, Tajikistan, Turkey, Ukraine, and Uzbekistan. A diverse selection of commercial, service and industrial firms within these countries will be the foundation of my analysis.

3.2. Limitations of Data

The data chosen, though robust in many respects[17], presents limitations for my analysis. Since the data is survey based, many of the variables are entirely dependent upon the firms' interpretation of each question; the measurements are self-reported. For

[16] Strict assumptions imply that direct contact was made with the entity; its eligibility is entirely confirmed. Median assumptions imply limited contact; some level of eligibility could be established. Lastly, with weak assumptions, there was no direct contact and thus no conclusions could be finalized.
[17] Observed data is robust in respect to the number of countries and firms surveyed, as well as the selection of questions contained in such surveys.

instance, when asked *"how much of an obstacle is: access to finance"*, the answers are subjective and not necessarily comparable to the reality of the firm's situation. Also, for questions as ambiguous as this, firms may choose either not to answer or to respond *'don't know',* which then leaves gaps in the recorded and subsequently observed data. This is the case with the variable Collateral, which asks firms to "*approximate the amount of collateral needed as a percent of the loan value / the value of the line of credit".* Nearly 18,000 observations are missing, which either suggests that firms do not have any collateral, or that they did not have the resources to estimate such collateral levels. This is problematic when testing the data, because accurate regression analyses cannot be run with such large differences between the numbers of observations; there exists nonresponsive as well as selection bias. Another limitation of the data is that the firms questioned across each examined period are not consistent; each year more firms are added and removed. This creates a gap and or potential misrepresentation of the nature of the data.

4. ECONOMETRIC SPECIFICATION

In this section I will present my econometric models and provide summary statistics for the observed variables. **Table 4** provides a more comprehensive outline of the variables, their definitions, means, standard deviations, and number of observations. To evaluate the impact financial stability and credit constraints have on a firm's innovational activity, I test the following probit regression models using panel data from the BEEPS 2002, 2005 and 2009 dataset:

Equation 1:

$$Innov_{isct} = \phi\{\alpha_0 FC_{isct} + \beta_1 \log L_{isct} + \beta_2 (\log L_{isct})^2 + \beta_3 EDU_{isct} + \beta_4 skillpercent_{isct} + \beta_5 age_{isct} + \beta_6 Intl_{isct} + \beta_7 priceratio_{isct} + \beta_8 SMNE_{isct} + \beta_9 IMPORT_{isct} + \beta_{10} citysize_{isct} + \beta_{11} OvDue_{isct} + \beta_{12} IntFunds_{isct} + \beta_{13} MangExp_{isct} + \lambda_s + \eta_c + \psi_t + error\}$$

Equation 2:

$$Upgrades_{isct} = \phi\{\alpha_0 FC_{isct} + \beta_1 \log L_{isct} + \beta_2 (\log L_{isct})^2 + \beta_3 EDU_{isct} + \beta_4 skillpercent_{isct} + \beta_5 age_{isct} + \beta_6 Intl_{isct} + \beta_7 priceratio_{isct} + \beta_8 SMNE_{isct} + \beta_9 IMPORT_{isct} + \beta_{10} citysize_{isct} + \beta_{11} OvDue_{isct} + \beta_{12} IntFunds_{isct} + \beta_{13} MangExp_{isct} + \lambda_s + \eta_c + \psi_t + error\}$$

In **Equation 1**[18]**,** *Innov* is a dummy variable equal to one if the firm has introduced any new products and or services in the past three years, and zero otherwise. In **Equation 2**[19]**,** *Upgrades* is a dummy variable equal to one if the firm has upgraded any existing product lines or services in the past three years, and zero otherwise. The c.d.f. of a standard normal random variable is denoted by ϕ, and subscripts ***i, s, c***, and ***t*** index firms, industry country, and time[20]. A collection of fixed effects is included to help evaluate the hypothesis: industry λ_s, country η_c, and year ψ_t. Such fixed effects are included to control for any factors that may be firm specific. The independent variables tested in this model capture the financial stability and credit constraints of the studied firms. In regressing these lagged variables against the innovational activity exhibited by firms, I expect to

[18] *Note:* The specifications in Equation 1 closely follow that of GS's work.
[19] *Note:* The specifications in Equation 2 closely follow that of GS's work.
[20] *Note:* to adjust for the endogeneity of financial constraints, lagged values of the variables could be used to capture the firms' performance three years earlier. However, since the inherent nature of both *Innov* and *Upgrades* captures the past three years of activity, the real value of each variable will be tested.

find that greater constraints and instability will hinder a firm's ability to innovate or upgrade its products.

4.1. Description of Variables

(Innov): The dependent variable in **Equation 1** captures firms' innovational activity within the past three years. The possible responses by firms were either yes, no, or don't know (spontaneous). When looking at a cut of the data in **Figure 2**, 56 percent of the firms answered yes and 44 percent answered no. Innovational activity *Innov* will be treated as a dummy variable equal to one if the firm answered yes, and zero if the answer was no.

(Upgrades): The dependent variable in **Equation 2** captures firms' upgrades to any existing products within the past three years. The possible responses by firms were either yes, no, or don't know (spontaneous). A cut of the data in **Figure 3** shows that roughly 40 percent of the firms did not upgrade, whereas 60 percent did. Upgrades to products *Upgrades* will be treated as a dummy variable equal to one if the firm answered yes, and zero if the answer was no.

(FC): The measure of financial stability and credit constraints faced by the firm is captured by the variable ***FC.*** This variable is composed of two sub-variables: *Difficulty of Access to External Finance (**AccFin)*** and *Collateral Needed (**Collateral)***.

(AccFin): To asses the difficulty a firm experiences when accessing external finance, the following question was asked in the survey: *How much of an obstacle is: access to finance?* The responses were measured on a 0 to 4 scale as follows: no obstacle, minor obstacle, moderate obstacle, major obstacle, and very severe obstacle. I expect that

if a firm experiences some degree of obstacle in obtaining finance, they will be less likely to innovate.

(Collateral): To measure the collateral needed, each firm was asked: *approximately how much collateral was needed as a percentage of the loan value and or the value of the line of credit?* I expect to find that the more collateral needed by the firm, the more financially constrained they will be and thus the less likely they will be to successfully innovate.

(L): To measure the relative size of the firms, ***L*** captures the number of employees. I expect the outcome to reflect how larger companies have more resources to innovate, and thus can benefit from economies of scale in R&D production and marketing; the larger the firm, the more likely it is to innovate or upgrade.

(EDU): The share of workers with a university education is included to reflect the involvement of workers in R&D activities. I expect to find that it will be positively correlated with innovation: the more educated the employees, the more they will be able to contribute to the development of new products and innovations.

(SKILL): The share of skilled workers captures the amount of human capital in the firm. The expected outcome of this variable is that it will be positively correlated with innovation: the more skilled the workers, the greater the insights they will have concerning how to improve the firms' products. ***(skillpercent)*** measures the percent of workers in a firm who were skilled workers in the last fiscal year by dividing *SKILL* by *L*.

I expect to find that this variable will exhibit a positive relationship with innovation as well.

(age): The age of the firm is measured as the number of years since operations began, using 2014 as the base year. Two possible outcomes can be expected from the age of a firm. Firstly, older firms could have developed routines resistant to innovation, making their innovational activities much less prominent than those of younger firms. Secondly, having years of experience, older firms could have the accumulated knowledge needed to innovate new products.

(Intl): A dummy variable capturing whether or not the firm competes in national markets. The expected outcome is that *Intl* will have a positive effect on innovation, since it would mean the firm is operating in a larger market. This implies that the firm would have more channels to sell their product, and thus a greater ability to increase their capital.

(Priceratio): The markup, or price to cost ratio of firms' products, is used to estimate the effect of competition faced by each firm. Since markup is both a proxy for profitability and a reflection of the supply and demand environment, the expected outcome is that it will be positively related with innovation: the higher a firm can markup its prices, the more revenue it will bring in, and thus the more internal funds it will have available to finance its innovations.

(SMNE) and ***(Import):*** The share of sales to multinational enterprises, as well as the share of imported inputs, is included to capture the vertical linkages or transfer of

capabilities amongst domestic and foreign firms. *Import* is a dummy variable equal to one if any of the firm's material inputs and supplies was directly imported, and zero otherwise. The expected outcome is that *SMNE* and *Import* will be positively correlated to innovation: exposure to foreign firms and markets may allow for the stimulation of more innovation. This potential increase in innovation could be due to technology spillovers, greater access to capital, or a combination of the two.

(citysize): A dummy variable capturing the size of the population where the firm operates, thus controlling for potential differences in larger and smaller cities, as well as the knowledge available. I expect to find that the larger *citysize*, the more likely it is for a firm to innovate or upgrade because it has more resources available.

(MangExp): Aggregates the number of years of experience the top manager has in their particular sector. This variable seeks to capture the culture of the firm and the nature of its organization. The expectation is that the more open a firm is in allowing the young to rise up into a manager position, the more likely a firm is to innovate new and creative products[21]. Therefore, the younger the manager, the more likely a firm will be to innovate. I have also limited the responses of particular variables by dropping any irrelevant responses.

Table 4: Definitions of variables and their descriptive statistics

Variable	Definition	μ	σ	N
Innov	1 if introduced new products or services in the last 3 years, else 0	0.43	0.50	22825
Upgrades	1 if in last 3 years, estab. upgraded an existing product line/service, else 0	0.59	0.49	22825
AccFin	Access to financing (1-no obstacle, 4-major obstacle)	1.41	1.24	22050

[21] *Source:* Acemoglu Daron, Akcigit Ufuk, Celik A. Murat, "Young, Restless and Creative: Openness to Disruption and Creative Innovations", *MIT Economics*, February 2014.

Collateral	Approx. collateral needed as % of the loan value\value of the line of credit	148.60	134.48	7488
lnL	Log of no. permanent, full-time employees at end of last fiscal year	111.37	412.47	22796
2lnL	Log squared of no. permanent, full-time employees			
EDU	% employees at end of fiscal year with a university degree	29.83	29.22	21646
SKILL	No. ft employees who were skilled prod. workers at end of last fiscal yr	62.58	240.85	17682
skillpercent	% ft employees who were skilled prod. workers at end of last fiscal yr	48.43	30.07	17682
age	How long ago (yrs) was this establishment formally registered?	19.66	13.68	7745
Intl	1 if estab. have an internationally-recognized quality certification, else 0	0.17	0.37	22825
priceratio	price of main product: (1-increase, 2-decrease, 3-same) in last yr	1.47	0.59	2390
SMNE	What % of establishment's sales were: national sales?	89.92	24.31	22783
Import	1 if any of these material inputs and supplies: imported directly, else 0	0.24	0.42	22825
citysize	City pop (1: cap city, 2: over 1mil, 3: 250k-1mil, 4: 50k-250k, 5: 50k less)	3.13	1.56	7745
MangExp	Number of years of experience top manager has	15.97	9.92	7745

Note: μ stands for the mean, σ for the standard deviation, and N for the number of observations.

4.2. Summary Statistics

Table 5 reports the summary statistics for each measure of innovation captured by the considered independent variables in **Equation 1** and **Equation 2**. This table reveals how the number of observations for each variable differs considerably among the following measures: Collateral, SKILL, skillpercent, age, priceratio, citysize, and MangExp.

Table 5: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Innov	22825	.4290033	.4949446	0	1
Upgrades	22825	.5922453	.4914279	0	1
AccFin	22050	1.408299	1.244209	0	4
Collateral	7488	148.5987	134.4759	1	8888
lnL	22795	3.205357	1.613555	0	9.809616
lnL2	22795	6.410714	3.227111	0	19.61923
EDU	21646	29.825	29.22171	0	100
skillpercent	17682	48.43463	30.06791	0	333.3333
age	7745	19.66482	13.6761	6	189
Intl	22825	.1670975	.3730711	0	1
priceratio	2390	1.466946	.5897438	1	3
SMNE	22783	89.92121	24.31239	0	100
import	22825	.2351807	.424121	0	1
citysize	7745	3.130536	1.564927	1	5
MangExp	7745	15.97276	9.922656	1	66

Source: BEEPS data. *Note:* if the variables listed above originally had a lower bound of -9, corresponding to the response '*don't know'*, these observations were dropped. Thus, the new lower bound for majority of the observations is 0.

4.3. I

nstrumentation Strategy

Gorodnichenko and Schnitzer (2011) note how firms who decide to innovate must incur expenses on developing that innovation, and thus are expected to run into financial constraints along the way. Conversely, firms who choose not to innovate avoid such financial burdens, and are thus less likely to experience financial constraints. Therefore, there could exist a positive relationship between innovational activity and financial constraints. To correct for this potential endogeneity, I include instrumental variables in my regressions[22]. These variables have an impact on a firm's financial constraints, but do not directly influence its innovational activity. To identify which variables to interact, I focus on those that capture liquidity shocks faced by the firms. An exogenous shock to a firm's liquidity situation affects not only the prevalence of its internal funds, but its attractiveness to creditors as well. The BEEPS Survey Data offers a collection of measurements that provide information explaining any exogenous shocks and or structure of a firm's revenues, two of which will be tested in my regressions: *OvDue* and *IntFunds*.

OvDue is a dummy variable equal to one if the firm has overdue payments to its suppliers, zero otherwise[23]. When analyzed in response to an unanticipated shock to a firm's cash flow, most firms claimed that they adjusted to the shock by delaying utility

[22] *Note:* When probit regressions are utilized to capture a dependent variable with a binary outcome, a possibility exists for biased coefficient estimates. In running IV regressions, I am able to account for such biases.

[23] *Note:* Overdue payments are classified as being utility payments overdue by more than 90 days.

payments (Gorodnichenko and Schnitzer (2011))[24]. Other prevalent responses were obtaining credit from banks, obtaining credit from suppliers, and delaying wage payments to workers[25]. The second instrumental variable, *IntFunds*, measures the percentage of fixed assets funded by internal funds or retained earnings in the last fiscal year. This is another important indicator, for it highlights the extent to which a firm is financially constrained. The more a firm finances its assets internally, the more likely they are to turn to external sources to help finance any innovational activity; any retained earnings are subsequently exhausted. Both of these instrumental variables provide an estimate of the true casual effects financial constraints have on firms' innovational activity.

5. EMPIRICAL RESULTS

In this section I present two techniques for testing **Equations 1** and **2**. The first subsection tests the baseline probit regression models and discusses its limitations. The second subsection discusses the IV regression models for both instrumental variables considered.

5.1. Probit Regression Results[26]

Since the dependent variable has a binary outcome, I use a probit regression model to estimate the effects of financial stability and credit constraints on innovation and upgrades. Preliminary regressions, however, yield results differing from existing literature. At the margin, neither *AccFin* nor *Collateral* exhibited statistically

[24] Gorodnichenko and Schnitzer (2011) used OvDue as an instrumental variable, and found that nearly 2,906 firms' response to cash flow shocks delayed payments as their source of financing the liquidity problem.
[25] These results are taken from Gorodnichenko and Schnitzer (2011)'s analysis.
[26] Though fixed effects would have captured any immeasurable effect year, country, or industry specific, such effects were not included in the final discussion of the empirical results; the numbers of observations in each specification were so high that none of the independent variables exhibited statistical significance.

significance. **Tables 6** and **7** display these results. Furthermore, the signs on the *FC* variables do not correspond with those expected from existing literature[27]. Both the difficulty of access to external finance and the collateral needed exhibit a positive sign, whereas the literature and my established hypothesis would expect the sign to be negative; the more financial constrained a firm, the less able they would be to innovate[28]. This divergence from the existing literature's findings reflects the endogeneity of the independent and dependent variables.

5.2. IV Regression Results[29]

5.2.1. Instrumental Variable Regression Results: Innovation[30]

IV regressions suggest a negative relationship between financial constraints and innovational activity. When interacted with *OvDue*, *AccFin* is negatively correlated and statistically significant at the one percent level, as seen in **Table 8** column 5. More specifically, for each increase in severity along the five-point *AccFin* scale, the likelihood of a firm to innovate decrease—on average—by 69 percent. This relationship suggests that *AccFin* is a good indicator of the financial constraints faced by firms. A series of variables positively impact firms' decision to innovate new products as well. The log of the number of full-time employees *(lnL)* is positive as well as statistically significant at the one percent level: for every one percent increase in *lnL*, the likelihood of *Innov* is expected to increase by 0.012 percent. This suggests that the more heavily employed a firm, the more likely they are to innovate. If a firm's material supplies are imported

[27] *See Appendix A*
[28] *Note:* In **Table 6** column 3, Collateral does exhibit a negative correlation with Innov. However, since Collateral reports no statistical significance, interpretations cannot be made.
[29] A series of IV regressions were run, and can be seen in Appendix. The regressions chosen for this analysis were the ones with the most statistically significant variables.
[30] *Note:* Each of these numerical results is taken at the margin with respect to each individual variable's standard deviation.

directly *(import)*, then their likelihood of innovating is expected to increase—on average—by 35 percent. The percent of workers considered skilled *(skillpercent)* also positively influences a firm's decision to innovate, though only with 10 percent significance: for each additional percent of an employee base that is skilled, the probability of a firm innovating increases by 0.15 percent. Each of these results is reported in column 5 of **Table 8** as well.

Using *IntFunds* as the instrumental variable in column 6 of **Table 8** suggests that *AccFin* is positively correlated at the 1 percent significance level, which contradicts both my expectations and the existing literature. It follows that for each increase in severity along the five-point *AccFin* scale, the likelihood of firms to innovate increases—on average—by 102 percent. This positive and lofty relationship could be due to the nature of *IntFunds* in the first stage regressions[31]. The percent of skilled workers also reveals a negative impact on innovation with only 10 percent confidence[32]: for each additional percent of an employee base that is skilled, the probability of a firm innovating decreases by 0.13 percent. As expected, however, the number of employees is a strong indicator of financial constraints, reporting at the 99 percent confidence level a positive impact on innovation. As was true with *OvDue* as an instrumental variable, however, the margin of this impact is small: for every one percent increase in *lnL*, the likelihood of *Innov* is expected to increase by 0.018 percent The percent of employees with a university degree

[31] *Note:* In the first stage regression results, *IntFunds* is both statistically significant and negative. Since the interaction variable is already negatively correlated with *Innov*, this could cause the sign of *AccFin* in this regression is positive.

[32] *Note:* This deviation from the expected results could be caused by the integration of *IntFunds* as an instrumental variable. As was seen with *AccFin* in this regression, because *IntFunds* is negative in the first stage results, this could impact the effect of particular variables. Why some variables are impacted over others may reflect each variable's standard deviation as well as its inherit sensitivity to change. If I had included elasticities in the tested regressions, then these deviations could be better explained.

(EDU) positively impacts innovation as well, and is significant at the 1 percent level: for each additional educated employee, the probability of a firm innovating increases—on average—by 0.54 percent. The nature of firms' imports also positively impacts innovational activity: if a firm's material supplies are imported directly, then—on average—their likelihood to innovate is expected to increase by 9 percent[33]. The inconsistencies found with respect to *AccFin* and *skillpercent* suggest that *IntFunds* is not a good indicator of the true casual effects financial constraints have on firms' innovational activity. Each of these results is reported in column 6 of **Table 8** as well. Though *IntFunds* was statistically significant in the first stage regression results with respect to *Collateral,* none of the variables exhibit statistical significance in the IV regression, as seen in column 7 of **Table 8.**

5.2.2. Instrumental Variable Regression Results: Upgrades

IV regressions also suggest a negative relationship between financial constraints and the firms' decision to upgrade an existing product. At the 10 percent significance level, each increase along the five-point *AccFin* scale is expected to decrease the likelihood of a firm to upgrade by 35 percent. This relationship is seen in column 8 of **Table 8.** The log of the number of employees in a firm *(lnL)*, the percent of them that are considered skilled *(skillpercent)*, whether or not the firm is internationally recognized (*Intl)*, and the nature of a firm's imports *(imports)* each have a positive impact on the decision to upgrade at the 1 percent significance level: for every one percent change in *lnL,* the likelihood of *Innov* is expected to increase by 0.011 percent; for each additional percent of the employee base that is considered skilled, the probability of a firm

[33] *Note:* import is statistically significant at 5 percent

innovating increases by 3 percent; if a firm answers yes to *Intl,* the likelihood of a firm innovating increases by 47 percent; and, if a firm imports supplies directly, their likelihood of innovating increases by 35 percent. These results suggest that *OvDue* is a good estimate of the true casual effects financial constraints have on firms' decision to upgrade its products.

As with *Innov,* using *IntFunds* as an instrumental variable with *Upgrades* yields different results then when interacted with *OvDue*. These results can be seen in column 9 of **Table 8[34].** Though statistically significant at 1 percent, *AccFin* reports a positive impact on *Upgrades:* for each increase along the five-point *AccFin* scale, the likelihood of a firm upgrading its products is expected to increase by 72 percent. As expected, however, the log of the number of employees positively influences the likelihood of upgrades with 99 percent confidence: for every one percent increase in *lnL,* the likelihood of *Innov* is expected to increase by 0.015 percent**.** An internationally recognized certificate *(Intl)* also positively impacts innovation, increasing the likelihood by 40 percent. The presence of directly imported materials is expected to increase the probability of innovation—on average—by 10 percent. Though *IntFunds* was statistically significant in the first stage regression results with respect to *Collateral,* only *Import* exhibits statistical significance in the IV regression, as seen in column 10 of **Table 8.** Due to the inconsistencies among the variables' statistical significance, as well as the strength of their impact, *OvDue* appears to be a more accurate instrumental variable than *IntFunds.*

6. CONCLUSION

[34] *Note:* The skill level of the employees *(skillpercent)* in this regression is no longer statistically significant, and thus was not included.

Various empirical studies suggest that financial frictions may create obstacles for both the R&D and investment opportunities for firms. On a macro scale, studies suggest that the development of a country's financial markets is correlated with its overall development. Data from these studies also suggests a positive correlation between R&D intensity and financial development among emerging market firms, proposing that proper financial management is crucial to innovational success. The existing literature surrounding such evidence has proposed several explanations behind these trends, captured within three main categories: financial development and economic growth, financing of R&D, and credit and internal financing constraints of R&D. This thesis provides new evidence on this relationship between financial constraints and innovation. Using the most current BEEPS Survey Data, I test the effects of financial stability and credit constraints on innovational activity by estimating unique financial indicators. I find that the greater difficulty a firm faces in accessing finance, the less likely they are to innovate a new product. I also find that they are less likely to upgrade an existing product, an indicator of innovational activity that has yet to be tested in the existing literature. These findings are parallel to those of Gorodnichenko and Schnitzer's (2011), who investigate financial constraints and their effect on firms' innovation and export activities. Their findings suggest that financial constraints restrain the ability of domestically owned firms to innovate and export.

More specifically, I find that particular characteristics of a firm have a statistically significant impact on both innovation and upgrades. The size of the employee base, the nature of the firms' imports, and the percent of employees who are skilled are all positively correlated with a firms' innovational activity, as well as whether or not it has

upgraded new products. This suggests that more financially developed firms have greater opportunities to increase their R&D intensity. The reasoning is as follows: i) they can afford to hire more employees, ii) they can afford to hire more *skilled* employees, iii) and they can afford to directly import their material and supply inputs, thus cutting down on intermediary costs. The firm then has not only a greater and stronger selection of human capital to generate new innovational ideas, but also a direct way of accessing the goods necessary. All of these combined provide the firm with a greater chance of generating revenue, and a smaller chance of incurring *binding* costs. These findings are consistent with those of Love (2003), who provides evidence suggesting that financial development impacts growth by reducing financing constraints that would otherwise distort efficient allocation of investment.

I also find, however, that using the approximate amount of collateral needed as a percentage of the loan value or value of the line of credit is not a strong measure of credit constraints; none of the regressions yielded statistical significance. Gorodnichenko and Schnitzer (2011) analyzed this aspect of financial constraints by testing the cost of external finance faced by the firm. Their findings suggest a strong negative casual effect of financial constraints on innovation. One reason why collateral may not have been a good indicator of innovational activity is because of the minimal number of observations available, nearly thirty percent less than many of the other variables. If these observations were available, I would expect the findings to be similar to those of Gorodnichenko and Schnitzer's (2011).

Furthermore, I find that a series of instrumental variables capturing liquidity shocks faced by the firms have a negative impact on innovational activity. Firms with

service payments more than 90 days overdue are more likely to experience difficulty in accessing finance. Similarly, firms with large amounts of their fixed assets funded by internal funds or retained earnings are more likely to have difficulty accessing finance. These findings are reflective of those by Guariglia, Alessandra, Liu, Xiaoxuan, Song, and Lina (2011), who suggest that the availability of internal finance represents a binding constraint for the growth of private firms. Thus, these two measurements are good indicators of the true casual effects financial constraints have on firms' innovational activity.

Collectively, these findings highlight important policy issues that require further analysis. A potential policy implication could be to enhance the access to external finance by lessening the difficulty faced by firms when obtaining loans, lines of credit, or investment opportunities. This would reduce firms' reliance on internal funds, minimize internal constraints, improve stability, and allow for more intensive innovational activity. Otherwise, a combination of poor access and high interest rates would discourage innovation, as well as impede convergence to the technological frontier. As Joseph Schumpeter (1912) explained, "well-functioning banks spur technological innovation by identifying and funding those entrepreneurs with the best chances of successfully implementing innovative products and production processes"[35]. Therefore, finding a way to minimize the difficulty faced by firms in accessing finance—perhaps through developing better functioning financial markets—will allow for a greater likelihood of firms innovating new products or upgrading existing ones.

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- Gorodnichenko Yuriy, Svejnar Jan, Terrell Katherine, "Globalization and Innovation in Emerging Markets", *American Economic Journal: Macroeconomics* Vol.2, No.2, April 2010, 194-226.

Tests for the effects of globalization through the impact of increase competition and FDI on firms' efforts to innovate. Finds that competition has a negative effect on innovation. Also finds that the supply chain of multinational enterprises and international trade are important channels for firm innovation.

- Guariglia, Alessandra, Liu, Xiaoxuan, Song, Lina, "Internal finance and growth: Microeconometric evidence on Chinese firms", *Journal of Development Economics*, Vol.96, Issue1, September 2011, 79-94.

Examines the extent to which liquidity constraints affect firms' asset growth. Find that the availability of internal finance represents a binding constraint for the growth of private firms.

- Levine, Ross, "Finance and Growth: Theory and Evidence", *National Bureau of Economic Research*. September 2004.

Reviews, appraises, and critiques theoretical and empirical research on the connections between the operation of the financial system and economic growth. Evidence suggests that better developed financial systems ease external financing constraints facing firms.

- Love, I. (2003), "Financial Development and Financing Constraint: International Evidence from the Structural Investment Model", *Review of Financial Studies,* 16: 765-791.

Provides evidence that financial development impacts growth by reducing financing constraints that would otherwise distort efficient allocation of investment.

TABLES

Table 6: Probit regression model for *Innov*, at the margin

TABLE 6:Probit Regression Results for Innov at the Margin

	(1) AccFin	(2) AccFin	(3) Collateral	(4) Collateral
AccFin	0.0283	0.0273		
	(0.0195)	(0.0196)		
lnL	0.0939***	0.232**		0.153
	(0.0211)	(0.0906)		(0.174)
priceratio	-0.137***	-0.134***		-0.0609
	(0.0454)	(0.0456)		(0.0831)
SMNE	-0.00697***	-0.00714***		-0.00466
	(0.00221)	(0.00223)		(0.00330)
import	0.361***	0.365***	0.139***	0.231**
	(0.0687)	(0.0698)	(0.0333)	(0.110)
citysize	-0.0637***	-0.0513***		-0.00620
	(0.0177)	(0.0190)		(0.0342)
MangExp	0.00649**	0.00680**		-0.00397
	(0.00263)	(0.00269)		(0.00481)
lnL2		-0.0180		-0.0108
		(0.0114)		(0.0205)
EDU		0.00228*	0.00321***	0.00774***
		(0.00121)	(0.000577)	(0.00273)
skillpercent		-0.00111		-0.000374
		(0.00108)		(0.00202)
age		0.00119		0.00342
		(0.00184)		(0.00333)
Intl		-0.0397		0.0387
		(0.0665)		(0.110)
Collateral			-0.000239	0.000969
			(0.000152)	(0.000605)
_cons	0.796***	0.527	-0.0375	0.348
	(0.271)	(0.327)	(0.0320)	(0.572)
N	2390	2390	7182	809

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
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Table 7: Probit regression model for *Upgrades*, at the margin

TABLE 7:Probit Regression Results for Upgrades at the Margin

	(1) AccFin	(2) AccFin	(3) Collateral	(4) Collateral
AccFin	0.00276	0.000991		
	(0.0217)	(0.0218)		
lnL	0.485***	0.495***	0.537***	0.567***
	(0.0945)	(0.0957)	(0.183)	(0.188)
lnL2	-0.0491***	-0.0497***	-0.0562***	-0.0566**
	(0.0119)	(0.0120)	(0.0213)	(0.0220)
EDU	0.00399***	0.00402***	0.0112***	0.0129***
	(0.00136)	(0.00136)	(0.00318)	(0.00343)
priceratio	-0.144***	-0.145***	-0.239***	-0.243***
	(0.0493)	(0.0494)	(0.0921)	(0.0932)
import	0.365***	0.361***	0.230*	0.273**
	(0.0772)	(0.0804)	(0.126)	(0.130)
citysize	-0.0419**	-0.0451**		0.0572
	(0.0211)	(0.0212)		(0.0396)
MangExp	0.00546*	0.00554*		-0.00557
	(0.00296)	(0.00302)		(0.00554)
skillpercent		0.00158		0.00332
		(0.00119)		(0.00234)
age		-0.00142		-0.00275
		(0.00198)		(0.00342)
Intl		-0.0485		-0.0593
		(0.0747)		(0.129)
SMNE		-0.00341	-0.00919**	-0.00881*
		(0.00250)	(0.00447)	(0.00455)
Collateral			0.000725	0.000707
			(0.000703)	(0.000704)
_cons	-0.126	0.138	0.700	0.324
	(0.226)	(0.361)	(0.612)	(0.688)
N	2390	2390	809	809

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 7 provides the coefficients of each baseline variable from **Equation 2** for four different probit regressions. Column 1 corresponds to the estimated regression in **Table 8** with *AccFin***.** Column 2 to the baseline probit regression model for *AccFin* with no variables omitted. Column 3 to the estimated regression in **Table 8** with *Collateral.* Column 4 to the baseline regression model for *Collateral.*

Table 8: Probit and IV Regression Results for *Innov* and *Upgrades*

TABLE 8:Probit and IV Regression Results for Innov and Upgrades

	(1) probit:Innov	(2) probit:Innov	(3) probit:Upg~s	(4) probit:Upg~s	(5) IV:Innov	(6) IV:Innov	(7) IV:Innov	(8) IV:Upgrades	(9) IV:Upgrades	(10) IV:Upgrades
AccFin	0.0283		0.00276		-0.697***	1.015***		-0.350**	0.724***	
	(0.0195)		(0.0217)		(0.189)	(0.184)		(0.164)	(0.113)	
lnL	0.0939***		0.485***	0.537***	0.116***	0.183***	-0.235	0.108***	0.152***	
	(0.0211)		(0.0945)	(0.183)	(0.0116)	(0.0158)	(0.458)	(0.0104)	(0.00969)	
priceratio	-0.137***		-0.144***	-0.239***						
	(0.0454)		(0.0493)	(0.0921)						
SMNE	-0.00697***			-0.00919**						
	(0.00221)			(0.00447)						
import	0.361***	0.139***	0.365***	0.230*	0.351***	0.0907**	0.448	0.345***	0.104***	0.435**
	(0.0687)	(0.0333)	(0.0772)	(0.126)	(0.0386)	(0.0431)	(0.427)	(0.0339)	(0.0300)	(0.176)
citysize	-0.0637***		-0.0419**							0.0276
	(0.0177)		(0.0211)							(0.0322)
MangExp	0.00649**		0.00546*							
	(0.00263)		(0.00296)							
Collateral		-0.000239		0.000725			-0.0982			-0.00561
		(0.000152)		(0.000703)			(0.132)			(0.0289)
EDU		0.00321***	0.00399***	0.0112***		0.00540***	0.00187			
		(0.000577)	(0.00136)	(0.00318)		(0.000682)	(0.00685)			
lnL2			-0.0491***	-0.0562***						
			(0.0119)	(0.0213)						
skillpercent					0.00153**	-0.00126*	0.00166	0.00294***		
					(0.000645)	(0.000744)	(0.00557)	(0.000560)		
Intl						0.407***	0.258	0.467***	0.402***	
						(0.0451)	(0.363)	(0.0315)	(0.0362)	
_cons	0.796***	-0.0375	-0.126	0.700	0.169	-2.303***	15.51	-0.0130	-1.250***	1.624
	(0.271)	(0.0320)	(0.226)	(0.612)	(0.257)	(0.275)	(21.59)	(0.223)	(0.177)	(3.756)
N	2390	7182	2390	809	16924	15902	5557	16924	22022	2632

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

The regressions chosen above in **Table 8** are a collection of those reported in Tables 6,7,9,10,11, and 12. These were chosen because the independent variables regressed are not only statistically significant, but also consistent with what the existing literature has discussed.

Table 9: IV regression results for *Innov* with *OvDue*, at the margin

TABLE 9:IV Regression Results for Innov

	(2) AccFin	(3) AccFin
AccFin	-0.697***	9.380
	(0.189)	(64.21)
OvDue		
lnL	0.116***	-0.303
	(0.0116)	(3.782)
skillpercent	0.00153**	-0.0247
	(0.000645)	(0.162)
import	0.351***	1.741
	(0.0386)	(9.468)
lnL2		0.0206
		(0.287)
EDU		-0.0128
		(0.104)
age		-0.0161
		(0.121)
Intl		3.011
		(20.95)
priceratio		0.234
		(2.568)
SMNE		-0.0131
		(0.0458)
citysize		0.680
		(5.022)
MangExp		0.0410
		(0.236)
Collateral		
_cons	0.169	-16.87
	(0.257)	(119.5)
N	16924	2390

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 9 depicts four IV regression models. Each of these regressions uses *Innov* as the dependent variable, and *OvDue* as the instrumental variable. Column 2 corresponds to the regression in **Table 8** with *AccFin.* Column 3 depicts the baseline regression model for *AccFin.* Column 4 depicts the first stage regression results for *Collateral.* Since *OvDue* is not statistically significant, further regressions were not run.

Table 10: IV regression results for *Innov* with *IntFunds*, at the margin

TABLE 10:IV Regression Results for Innov

	(2) AccFin	(3) AccFin	(5) Collateral	(6) Collateral
AccFin	1.015***	0.377		
	(0.184)	(0.244)		
IntFunds				
lnL	0.183***	0.151	-0.235	-0.126
	(0.0158)	(0.134)	(0.458)	(0.462)
EDU	0.00540***	0.00211	0.00187	0.00521
	(0.000682)	(0.00184)	(0.00685)	(0.00942)
skillpercent	-0.00126*	-0.00195	0.00166	-0.00226
	(0.000744)	(0.00169)	(0.00557)	(0.00298)
Intl	0.407***	0.0724	0.258	0.124
	(0.0451)	(0.117)	(0.363)	(0.185)
import	0.0907**	0.455***	0.448	0.279*
	(0.0431)	(0.101)	(0.427)	(0.165)
lnL2		-0.0118		0.0190
		(0.0160)		(0.0542)
age		0.00161		0.00161
		(0.00262)		(0.00617)
priceratio		-0.111		0.0469
		(0.0690)		(0.157)
SMNE		-0.00226		0.00204
		(0.00295)		(0.00506)
citysize		0.00155		-0.0281
		(0.0339)		(0.0545)
MangExp		0.00535		0.000250
		(0.00400)		(0.00758)
Collateral			-0.0982	-0.00912
			(0.132)	(0.0157)
_cons	-2.303***	-0.288	15.51	1.794
	(0.275)	(0.621)	(21.59)	(2.952)
N	15902	2390	5557	809

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 10 depicts six IV regression models. Each of these regressions uses *Innov* as the dependent variable, and *IntFunds* as the instrumental variable. Column 2 corresponds to the regression in **Table 8** with *AccFin.* Column 3 depicts the baseline regression model for *AccFin.* Columns 4 through 6 depict the same, yet for *Collateral.*

Table 11: IV regression results for *Upgrades* with *OvDue*, at the margin

TABLE 11:IV Regression Results for Upgrades

	(2) AccFin	(3) AccFin
AccFin	-0.350**	19.63
	(0.164)	(134.3)
OvDue		
lnL	0.108***	-0.628
	(0.0104)	(7.910)
skillpercent	0.00294***	-0.0479
	(0.000560)	(0.339)
Intl	0.467***	6.355
	(0.0315)	(43.82)
import	0.345***	3.252
	(0.0339)	(19.80)
lnL2		0.0312
		(0.600)
EDU		-0.0277
		(0.218)
age		-0.0378
		(0.252)
priceratio		0.627
		(5.370)
SMNE		-0.0159
		(0.0958)
citysize		1.489
		(10.50)
MangExp		0.0772
		(0.494)
Collateral		
_cons	-0.0130	-36.40
	(0.223)	(249.9)
N	16924	2390

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 11 depicts four IV regression models. Each of these regressions uses *Upgrades* as the dependent variable, and *OvDue* as the instrumental variable. Column 2 corresponds to the regression in **Table 8** with *AccFin.* Column 3 depicts the baseline regression model for *AccFin.* Column 4 depicts the first stage regression results for *Collateral.* Since *OvDue* is not statistically significant, further regressions were not run.

Table 12: IV regression results for *Upgrades* with *IntFunds*, at the margin

TABLE 12:IV Regression Results for Upgrades

	(2) AccFin	(3) AccFin	(5) Collateral	(6) Collateral
AccFin	0.724***	0.401		
	(0.113)	(0.281)		
IntFunds				
lnL	0.152***	0.329**		0.430
	(0.00969)	(0.148)		(0.458)
Intl	0.402***	-0.0371		-0.126
	(0.0362)	(0.135)		(0.190)
import	0.104***	0.457***	0.435**	0.402**
	(0.0300)	(0.120)	(0.176)	(0.172)
lnL2		-0.0315*		-0.0433
		(0.0178)		(0.0538)
EDU		0.00248		0.0141
		(0.00212)		(0.00959)
skillpercent		0.000615		0.00389
		(0.00193)		(0.00308)
age		0.00127		-0.000549
		(0.00308)		(0.00599)
priceratio		-0.101		-0.152
		(0.0791)		(0.157)
SMNE		-0.00272		-0.00440
		(0.00355)		(0.00565)
citysize		0.0340	0.0276	0.0965*
		(0.0393)	(0.0322)	(0.0544)
MangExp		0.00331		-0.0000641
		(0.00466)		(0.00774)
Collateral			-0.00561	0.00427
			(0.0289)	(0.0159)
_cons	-1.250***	-0.370	1.624	-0.577
	(0.177)	(0.721)	(3.756)	(2.986)
N	22022	2390	2632	809

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 12 depicts six IV regression models. Each of these regressions uses *Upgrades* as the dependent variable, and *IntFunds* as the instrumental variable. Column 2 corresponds to the regression in **Table 8** with *AccFin.* Column 3 depicts the baseline regression model for *AccFin.* Columns 4 through 6 depict the same, yet for *Collateral.*